TABLE I

SIZE AND PERCENTAGE OF BARK IN SECTIONS OF CHINESE CHESTNUT TREES

Section of Tree	Circumference of Fresh Section, with Bark			Diameter of Air-dry Section, without Bark		Proportion of Bark in Air-dry Sections		
	Tree B2 Inches	Tree E2 Inches	Tree E3* Inches	Tree B2 Inches	Tree E2 Inches	Tree B2 Per Cent.	Tree E2 Per Cent.	Tree E3 Per Cent.
root	18.0	16.0	11.5	4.6	4.1	11.3	10.7	14.8
crown	44.5	51.0	33.0	12.5	13.5	8.8	13.2	14.0
trunk (1)	36.5	41.0	24.5	10.2	11.3	10.8	13.3	17.3
trunk (2)	27.0	25.0	13.0	7.6	7.0	13.9	14.6	14.4
trunk (3)	19.0	18.0	9.5	5.2	4.9	15.0	16.4	13.9
branch	6.0	6.8	5.7	..	..	19.3	17.5	17.5

*Measurements made in 1928.

than an increase was found in the proportion of bark in cross sections taken along the trunk. The thickness of the root, crown, and trunk (1) bark, although difficult to measure accurately because of its irregularity, was approximately the same in 1937 as in 1928. Since the diameter of these sections increased without a change in the thickness of the bark, the proportion of bark was lower in 1937 than in 1928.

The values for proportion of bark given in Table I are on the air-dry basis. Where data were available, these values were calculated to the moisture-free basis. When calculated on this basis, the figures were changed by less than one per cent.

As in the previous work, the tannin analyses were made by the methods of the American Leather Chemists Association except that no charge greater than 65 grams was used for extraction. If the tannin concentration of the analytical solution was less than four grams of tannin per liter, the amount of wet, chromed hide powder was reduced proportionally.

The results for tannin and sugars are given in Tables II and III. Comparison of the average results for trees B2 and E2 with those for tree E3 shows that tannin in the wood had increased by about one per cent in all sections throughout the tree. But if the comparison is made with the averages for all five trees examined in 1928 rather than with the results for tree E3, an increase of about 3.5 per cent is found. This difference results from the fact, as shown in the previous article[1], that tannin in the various wood sectioins of tree E3 was appreciably higher than it was in corresponding sections of the other four trees.

The tannin content of the crown section of tree B2 was greater than that of the trunk sections but was equalled by that of the root, while the maximum tannin content of tree E2 was in the trunk (1) section.

Tannin in the wood decreased from the crown to the branches in tree B2 and from the trunk (1) location to the branches in tree E2. This decrease was probably related to the age of the section. The upper trunk and branches

TABLE II

TANNIN AND NON-TANNINS IN CHINESE CHESTNUT TREES

(On moisture-free basis)

(Trees B2 and E2 sampled in 1937, E3 in 1928)

Section of Tree	Tannin				Non-Tannins			
	Tree B2	Tree E2	Average	Tree E3	Tree B2	Tree E2	Average	Tree E3
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Wood from:								
root	14.2	9.6	11.9	10.6	4.3	7.1	5.7	8.2
crown	14.2	12.7	13.6	12.9	3.5	3.5	3.5	2.7
trunk (1)	13.4	14.7	14.1	12.6	3.6	4.2	3.9	4.0
trunk (2)	10.9	13.8	12.4	8.8	3.7	4.5	4.1	3.4
trunk (3)	9.6	9.6	9.6	8.3	3.7	3.7	3.7	4.0
branch (1)	7.1	4.8	..	5.2	4.0	4.2	..	4.2
branch (2)	8.3	4.5	..	4.7	4.0	4.7	..	4.7
branch (3)	9.1	4.6	..	6.3	4.0	4.2	..	4.6
branch, average	8.2	4.6	6.4	5.4	4.0	4.4	4.2	4.5
Bark from:								
root	24.8	26.0	25.4	30.8	13.3	13.9	13.6	16.5
crown	16.0	16.2	16.1	18.2	10.1	8.5	9.3	9.5
trunk (1)	17.6	16.4	17.0	17.0	8.7	8.6	8.7	8.8
trunk (2)	15.3	13.9	14.6	13.3	9.0	9.1	9.1	10.7
trunk (3)	15.4	14.4	14.9	..	10.3	9.8	10.1	..
branches	11.1	10.4	10.8	13.8	10.7	11.3	11.3	14.4

were of course a few years younger than the crown section and, as has just been pointed out, tannin is slightly lower in young than in old wood.

Tannin was higher in the bark than it was in the wood of the various sections. As in 1928, the highest tannin content of any portion of the tree was in the root bark. Bark tannin during the nine-year interval had changed very little in the trunk but was about five per cent lower in the root, two per cent lower in the crown, and three per cent lower in the branches.

Non-tannins in the wood were almost the same in 1937 as they were in 1928 in all sections except the root and crown. In the root wood, non-tannins decreased about 2.5 per cent; in the crown wood, they increased by about one per cent.

Non-tannins in the bark were lower in 1937 than they were in 1928 in all sections except the crown and trunk (1), where they remained constant.

The significant changes in the amounts of sugars in the different parts of the tree, as shown in Table III, are proportionately large decreases in both total and reducing sugars in the root wood and bark and in the branch bark, and moderate decreases in the upper trunk wood and bark. These are the locations in the tree that have the highest sugar content. The range, therefore, in sugar content for the various portions of the tree was less in 1937 than in 1928.

TABLE III

REDUCING AND TOTAL SUGARS IN CHINESE CHESTNUT TREES

(On moisture-free basis)

(Trees B2 and E2 sampled in 1927, E3 in 1928)

	REDUCING SUGARS						TOTAL SUGARS					
	Tree B2 Per Cent	Tree E2 Per Cent	Trees B2, E2 Average Per Cent	Tree E3 Per Cent	Trees B2, E2 Average Ratio to Tannin*	Tree E3 Ratio to Tannin*	Tree B2 Per Cent	Tree E2 Per Cent	Trees B2, E2 Average Per Cent	Tree E3 Per Cent	Trees B2, E2 Average Ratio to Tannin*	Tree E3 Ratio to Tannin*
Wood of:												
root	1.3	3.0	2.2	4.5	18	42	1.6	3.3	2.5	4.9	21	46
crown	0.7	0.6	0.7	0.5	5	4	1.0	1.0	1.0	1.1	7	9
trunk (1)	0.6	1.1	0.9	0.8	6	6	0.9	1.7	1.3	1.4	9	11
trunk (2)	0.7	1.1	0.9	0.6	7	7	1.2	1.7	1.5	1.1	12	13
trunk (3)	0.6	0.7	0.7	1.1	7	13	1.1	1.2	1.2	1.6	12	19
branch (1)	0.7	1.0	..	1.4	..	..	1.5	1.5	..	1.8	..	..
branch (2)	0.8	1.5	..	1.5	..	..	1.4	1.9	..	1.9	..	..
branch (3)	0.8	1.1	..	1.2	..	..	1.2	1.5	..	1.5	..	..
branch, average	0.8	1.2	1.0	1.4	16	26	1.4	1.6	1.5	1.7	23	31
Bark of:												
root	6.2	5.8	6.0	10.4	24	34	6.8	12.4	9.6	11.0	38	36
crown	2.7	1.3	2.0	1.9	12	10	3.7	2.3	3.0	3.2	19	18
trunk (1)	1.4	1.6	1.5	1.6	9	9	2.4	2.6	2.5	2.7	15	16
trunk (2)	1.9	1.9	1.9	2.6	13	20	3.2	3.1	3.2	4.5	22	34
trunk (3)	2.0	1.9	2.0	..	13	..	3.6	3.3	3.5	..	24	..
branches	1.6	2.5	2.1	4.9	19	36	3.7	4.4	4.1	7.4	40	54

*Parts of sugar per 100 parts of tannin.

Not only sugars but also tannin in the bark and non-tannins in both wood and bark showed narrower ranges in values in the older trees. Roots especially, and to some extent the branches, of the young trees showed high values for these constituents. With age these high values moderated, and the tree became more uniform in composition throughout its length.

At times it may be desirable to know the approximate tannin content of a tree without disturbing the trunk. If a constant ratio should exist between tannin content of the branches and that of the trunk this could be accomplished. In 1928 the ratio of tannin in the bark of trunk (1) and (2) sections to that in the bark of branches was found to be 1.4. The ratio for both tree B2 and tree E2 was 1.5, which supports the tentative conclusion given in the previous report[1] that for practical approximations tannin in the trunk bark of this species is about one and one-half times that in the bark of the branches. In 1928 the average ratio of tannin in trunk wood to that in branch wood was 2.7, but the ratios for the five trees ranged from 2.0 to 3.3. The corresponding ratios for trees B2 and E2 were 1.5 and 3.1, respectively. The variation is so great that the tannin content of branch wood is of little value in estimating the tannin content of trunk wood.

To summarize: This report, which presents results for comparable Chinese chestnut trees sampled nine years apart, shows that there was an increase of a little more than one per cent in the tannin content of the wood throughout the tree during this period. Relatively large decreases were found in non-tannins and sugars in the root wood, and in tannin, non-tannins, and sugars in the bark of roots and branches. The difference in tannin content between the various parts of the tree generally became less as the tree aged. This was also true for the non-tannin and the sugar content.

Reference

1. Tannin Data on Hairy Chinese Chestnut Trees Grown in the United States, by I. D. Clarke and R. W. Frey (with introduction by G. F. Gravatt). *J.A.L.C.A.*, **27**, 206 (1932).

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Discussion

C. R. Oberfell: I think this is an interesting investigation and an excellent thing to have in the record. The first point that strikes me is the comparison with our American chestnut. I find that the tannin content is far in excess of our American chestnut today. Of course, these are live trees. Today we have mostly dead chestnut trees. But we have not found that the tannin content of our American chestnut decreases with the age of the tree or the time it has stood since it died. Today, if we find an American chestnut that runs up to 11 per cent tannin, we consider it an excellent one. That was not true a few years ago, but it is today. The average, I would say, is around 9 per cent. A great deal of it is lower than 9 per cent.

Another difference with our American chestnut is the amount of tannin that is in the bark. There is very much less tannin in the bark of our American chestnut than there is in the Chinese chestnut, apparently. American chestnut bark shows around 3 or 4 per cent of tannin.

Now, the original idea of the Department of Agriculture was to use these Chinese seedlings for reforestation purposes to replace our dead and dying American chestnut; but I believe they have given that up.

I talked recently with Mr. Gravatt at the Bureau of Plant Industry, and he said they were no longer recommending Chinese chestnut for that purpose. They are now only appealing to farmers to use these seedlings for planting an acre or two on farms, primarily for their food value and somewhat for their decorative value.

L. M. WHITMORE: There has been a lot of data submitted to indicate that chestnut does not deteriorate after it dies. From an analytical standpoint that is probably true. But people who buy chestnut wood know that although you may get wood with an analysis on a dry basis of 9 per cent now, you don't get as much dry wood per cord, because the tree left standing after it dies decreases in total solids per cubic foot. Isn't that correct?

OBERFELL: I think it is. We have not found it to be very marked; but it is true. I made the statement that at the present time our American chestnut contains considerably less tannin than it did a few years ago. I think this is due to the fact that all of the lowland chestnut has been cut out and utilized. They are now cutting from the higher altitudes, and the higher altitude trees always contain much less tannin. But we have found that from live trees and dead trees at the same altitude there has been no marked change in the percentage of tannin by analysis.

H. B. WALKER: Mr. Chairman, is it in order to ask why this work was started? What was the object in importing these trees and having them planted, and in making these studies?

OBERFELL: I just made the statement a minute ago that the object was to reforest our mountains. American chestnut died out with no hope of its coming back. These chestnut trees of Chinese origin are blight-resistant, or nearly so; but the characteristics of the Chinese tree are so different from our American type, particularly in their wood growth, that they do not produce nearly as much wood as the American chestnut does over the same period of time. This, together with the difficulty of going in and reforesting these mountains all down through the Blue Ridge system and the Alleghenies, is an impossible proposition. This is the reason why the Department of Agriculture has given up its original object of replacing American chestnut with the Chinese.

WALKER: Thank you very much.

I. D. CLARKE: Was it recently that you talked with Mr. Gravatt of the Bureau of Plant Industry?

OBERFELL: In the last two months.

CLARKE: These trees were planted in an orchard. They were the orchard type, and became very bushy and when cut back, formed almost a hedge, or dense grove. But certain trees, planted in the forest-type planting, were found that made a large growth and really looked favorable for use in producing tannin. Mr. Diller went over all the plantings and resurveyed them about a year ago. I have never talked to him since. I don't know what he found out. But I understand if they are planted under forest conditions they appear to be satisfactory.

OBERFELL: I make one comment on that: Mr. Gravatt said that the trees that were grown under forest conditions were very much better than those grown under orchard conditions. But still they decided not to continue to use them for reforestation.

CLARKE: They have used Japanese as well as Chinese. We have analyzed some Japanese varieties. They have about the same tannin content as the Chinese, but I don't know about their growth habits.

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Effect of Age on the Size and Tannin Content of Chinese Chestnut Trees Grown in Maryland*

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In 1932 a report[1] was made on the tannin content of five hairy Chinese chestnut trees of the species *Castanea mollissima*, supplied through the courtesy of the Division of Forest Pathology, Bureau of Plant Industry, U. S. Department of Agriculture. These trees had been planted in an orchard at Bell, Md., in 1912, as seedlings grown from seed obtained in Tientsin, China. They were about sixteen years old when removed for analysis on April 7, 1928.

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Nine years later, on March 10, 1937, two additional trees were obtained from this orchard through the same agency. At each date the trees were dormant, although it was near the time of year for the buds to swell. Data on size and tannin and sugar contents of the trees removed in 1937 are reported herein and compared with the results for the trees removed earlier.

The orchard is located on a hillside with a moderate slope to the west. Trees B2 and E2, removed in 1937, grew close together near the edge of the orchard at the foot of the slope. Tree E3, which was examined in 1928, also grew in nearly this same location. The other four trees removed in 1928 grew farther up the hillside and were smaller than E3, probably because the soil was not so rich or so moist on the side of the hill as at its foot. Therefore, the data for tree E3 have been given in the tables, and the averages for all five trees examined in 1928 have been omitted because they do not differ much from the results for tree E3 except for tannin in the wood, and this difference will be discussed in the text.

Measuring and sampling was done in exactly the same manner for all trees. First, they were dug up and measured, then sections eight inches long were sawed from the largest root, the crown, the trunk, and the branches of each tree. The crown section was taken at ground level, where the trunk bark and the root bark meet. Three trunk sections were taken trunk (1) at about sixteen inches from the ground level, trunk (3) just below the first large branch, and trunk (2) midway between the other two trunk sections. From these 8-inch sections the analytical samples were prepared by chopping and grinding a suitable portion of wood or bark. Wood samples represented entire cross sections of root, trunk or branches, exclusive of bark. Bark samples comprised the bark entirely encircling the corresponding wood sections.

The size of the trees increased appreciably during the nine-year interval between the taking of the first and second sets of samples. Heights and diameters at the later date were from 1.5 to 2 times as great as at the earlier date. In 1928 the trees were from 20 to 24 feet tall. In 1937 trees B2 and E2 were 31.5 and 34 feet tall, respectively. Table I, which gives the diameter and circumference measurements, shows that the circumferences of the trunk (1) sections of B2 and E2 were about one and two-thirds times as great and those of the trunk (2) and trunk (3) sections about twice as great as the circumferences of corresponding sections of tree E3.

Because of the irregular shape of the roots and crowns, their measurements were not entirely satisfactory. They showed, however, about the same relative increase in size as the trunk sections. The change in size of the branches was not determined. In both years only limbs between 1.5 and 2 inches in diameter were selected.

In trees B2 and E2 the percentage of weight of bark in the air-dry sections increased regularly up the trunk from the crown location to the branches, as shown in Table I. This was not true for tree E3, in which a decrease rather